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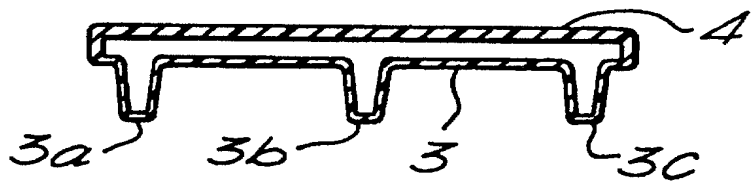
(54) Title: INSULATED STRUCTURE FOR THE CASING OF A REFRIGERATION APPLIANCE

(57) Abstract

An insulated structure such as the door of a refrigeration appliance is formed in one operation by simultaneously vacuum forming two layers of plastics material (7, 8) against respective tools (12, 13), and bringing the tools together with such a force that material is displaced from the peripheral seam, in order to provide an integrated structure along the seam which lends strength to the seam.



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Insulated Structure for the Casing of a Refrigeration Appliance

This invention relates to the fabrication of an insulated structure for the casing of a refrigeration appliance.

Typically, an insulated structure such as the door panel or panels of a refrigeration appliance such as a refrigerator, a freezer, or a combined refrigerator and freezer, has an outer skin of stamped and formed metal, and an inner liner of plastics material which is formed, e.g. by vacuum forming, with integral receptacles and supports for trays and components.

It has been proposed (US-A-5 306 082) to form both the outer skin and the inner liner of a refrigerator door from plastics material, filling the space between them with foam to provide stiffening. However, it is only possible to produce simple shapes for the outer skin and the inner liner with the method of fabrication employed, in which an envelope of heated plastics material is pressurized to force it into contact with two mould pieces (so-called "blow-moulding"). In order to end up with the required supports for shelves on the inner skin, suitable components are first of all loaded into one of the mould pieces, in order for them to adhere to the inner skin during the blow-moulding process.

The invention provides a method of fabricating an insulated structure forming part of the casing of a refrigeration appliance, which comprises applying reduced pressure to draw a pair of sheets of plastics material against opposed tools to form respective layers which provide inner and outer skins of the appliance casing, wherein the tools are brought together with a force sufficient to displace plastics material away from a peripheral seam along which the

sheets are welded.

The combination of the use of vacuum forming and pressure sufficient to displace material from the seam enables details such as shelf supports to be moulded integrally with the inner skin, a satisfactory appearance for the outer skin as well as a robust seam between the inner and outer skins, to be achieved.

Excess material may thereafter be trimmed from the structure thus formed. The force with which the tools are brought together is preferably sufficient to squeeze the seam to a thickness of less than two-thirds, and preferably less than one half, of the combined thickness of the sheets before the tools are brought together.

It may be desirable to use dissimilar materials for the outer skin and inner skin.

The space between the skins may be filled with foam, or with solid filling material thereafter evacuating the space between the skins.

The insulated structure may be a door of a refrigerator, freezer, or combined refrigerator/freezer, but it is also possible to fabricate the cabinet of such an appliance as well using the method of the invention.

The invention also provides an insulated structure fabricated in accordance with the method of the invention.

Insulated structures for the casing of a refrigeration appliance, fabricated in accordance with the invention will now be described, by way of example, with reference to the accompanying drawings, in which:

Figure 1 is a perspective view of a refrigerator;

Figure 2 is a plan view of the door of the refrigerator;

Figure 3 is a front elevation of the door of the refrigerator;

Figure 4 is a side elevation of the door of the refrigerator;

Figure 5 is a fragmentary section through the top of the door taken through the lines A-A in Figure 3;

Figure 6 is a schematic view of apparatus for fabricating the door shown in Figures 1 to 5;

Figure 7 is a sectional view of the door after fabrication, and corresponding to the sectional view B-B in Figure 1;

Figure 8 is a view on an enlarged scale of a part of the apparatus of Figure 6;

Figure 9 illustrates a prior art method of welding;

Figure 10 illustrates one form of sheet of plastics material;

Figure 11 illustrates schematically apparatus for fabricating an insulated structure which forms the cabinet of the refrigerator of Figure 1; and

Figure 12 is a horizontal cross-section through the insulated structure fabricated by the apparatus of Figure 11 and corresponding to a horizontal section through the cabinet of the refrigerator shown in Figure 1.

Like parts have been given like reference numerals throughout all the figures.

Referring to Figure 1, the refrigerator consists of a door 1 and a cabinet 2 each fabricated in accordance with the invention. The refrigerator is fitted with a compressor, a condenser and an evaporator in a refrigeration circuit, but these are not illustrated. The door consists of an inner skin 3 and an outer skin 4 (Figure 7), and the cabinet consists of an inner skin 5 and an outer skin 6 (Figure 12).

It can be seen from Figures 1 and 7 in particular that the inner skin 3 has, formed integrally with it, vertically extending ridges 3a-3c. The inner skin of the door 3 also has a recess 3d (seen only in Figure 5) which extends around the periphery of the door and serves as a groove in which a door seal incorporating a magnet (not shown) is attached in use. The outer skin of the door, as seen in Figures 2 and 5, has an integral recess 4a which serves as a handle for opening the door.

The inner skin 5 of the cabinet has raised ribs 5a-5c to hold shelves (not shown). The projections 3a-3c also have raised bosses or ribs which are not shown in order to support shelves and compartments.

With reference to Figure 6, the door is fabricated as follows. Two sheets of plastics material 7, 8 are heated respectively, from the top and from the bottom until they are respectively above their softening points, while being held apart by frames 9, 10 and 11.

The sheets are then moved sideways to a position between a pair of tools 12, 13. These are maintained at a temperature just below the softening point of the respective plastics materials. The tools are shown as having respective orifices 12a, 13a but, in practice, each tool would have several hundred such orifices. The orifices are provided in order to apply a vacuum to the front face of the tools.

In operation the tools 12, 13 are brought together until rectangular raised ridges 12b, 13b come into contact with the respective sheets 7, 8. At this point, the vacuum is applied in order to vacuum form the sheet 7 against the tool 12 and the sheet 8 against the tool 13. Orifice 10a in frame 10 permits the necessary inrush of air. Up to this point the sheets 7, 8 are still separate from each other, but the tools continue to be brought together until the sheets 7 and 208 are in contact with each other between the peripheral rectangular ridges 12b, 13b. The force urging the tools together is such that the layers 7 and 8 are not merely brought into contact with each other, as for example is typically the case with some operations as in the prior art illustrated in Figure 9 (showing sheets 14 and 15 brought together by tools), but with such a force as to displace material from the line of the seam, so that the combined thickness at the

line of the seam is less than the combined thickness of the two sheets 7 and 8. This is clearly seen in Figure 8. It should be noted that the ridges 12b, 13b are simplified in Figure 6. The effect of the displacement of plastics material away from the seam is firstly that the seam (line C-C) is around one half of the combined thickness of the uncompressed layers 7 and 8, and secondly that material has been displaced in the form of a bulge 16 to form a bead around the inner edge of the seam. Note where the undistorted edge of sheet 4 would be in Figure 8 at dotted line 17. The sheets can be of dissimilar plastics material, but the squeezing of the material results in an integrated structure at the seam.

The temperature of the tools is lower than the softening temperature of the sheets 7 and 8, and so the sheets gradually harden, whereupon air is now blown into the orifices 12a, 13a in order to separate the tools. The moulding is now trimmed at lines C-C, for example by the use of a guillotine, although routing or laser cutting could be used if desired. The unsatisfactory nature of a seam produced by contact welding of Figure 9 would be particularly apparent after the trimming operation, since the sheets would be prone to separate along the seam.

An aperture not shown is left in the lower side wall of the sheet 4, and plastics foam material, for example polyurethane, can be injected into this hole to fill up the space between the skins 3 and 4. As an alternative, the hole can be filled with granules of powder such as silica or fly ash (EP 0 190 582, EP 0 254 993) by vibrating the moulding, whereupon vacuum can be applied to the aperture before sealing it, in order that the door is insulated in effect by a vacuum. In the latter case, it is necessary for each sheet of plastics material to consist of a multi-layer structure, in that in addition to the structural layer 18, the sheet also has an integral gas impermeable layer such as EVOH (ethylene vinyl alcohol) together with a water barrier

20 such as polypropylene.

The door thus produced has an acceptable outside appearance, is rigid because of the filling material, and has the required integral formations on the inner skin for attachment of the usual 5shelves, and all this has been achieved in one moulding and one filling operation.

It will generally be found desirable for the outer skin 7 to be formed of a thicker plastics material than the inner sheet 8. Suitable materials for the outer skin are ABS (acrylo-nitrile butadiene styrene), high impact polystyrene, polycarbonate or polypropylene. Suitable 10materials for the inner skin are any of the above excluding polycarbonate which would generally not be used for the inner skin because of its higher expense. A typical thickness for the layers would be 5mm for the outer layer and 3mm for the inner layer, and a typical thickness after squashing between the tools would be less than 4mm. Generally, the outer material is chosen for its appearance and the inner skin for its ability to be deep drawn.

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It should be added that, in the case of undercuts such as the recess 4a, the tool may have retractable parts in order for the tool to be withdrawn from the moulding. This would also be true for recesses formed to accommodate hinge structures.

20The same procedure is adopted for the fabrication of the cabinet (Figures 11 and 12). In a similar manner to the production of the door, sheets of plastics material (whether laminated or otherwise) held between frames 9, 10 and 11 are heated to above the softening point of the relevant materials and brought laterally between a pair of tools 21, 22. The tools 21 and 22 are brought together until the rectangular ridges 21b, 22b come into contact with the sheets,

whereupon the sheets can be drawn against the respective tools by means of vacuum applied at one of several hundred orifices such as those indicated at 21a, 22a. The closing pressure of the tools is maintained until material is displaced from the seam line to such an extent that the combined thickness of material at that line is less than the combined thickness of the undistorted sheets. The aperture 10a allows air in to allow the sheets to be drawn over the tools.

Typical materials for the inner skin layer 7 are: crystal polystyrene, high impact polystyrene, ABS, polypropylene; and typical materials for the outer skin layer 8 are: those for the inner skin or polycarbonate. Suitable thicknesses would be around 5mm for the inner skin 7 and around 6mm for the outer skin 8. The sheets 7 and 8 could be of laminated construction as for the door.

In this way, a cabinet 2 is formed in one operation, and it is merely necessary to attach the refrigeration apparatus, preferably as a module to it.

Of course, variations may be made without departing from the scope of the invention. Thus, while the embodiment is a refrigerator, the invention is also applicable to a freezer, or to a fridge/freezer having one or multiple doors for respective compartments.

CLAIMS

1. A method of fabricating an insulated structure forming part of the casing of a refrigeration appliance, which comprises applying reduced pressure to draw a pair of sheets of plastics material against opposed tools to form respective layers which provide inner and outer skins of the appliance casing, wherein the tools are brought together with a force sufficient to displace plastics material away from a peripheral seam along which the sheets are welded.

2. A method as claimed in claim 1, in which the force is sufficient to displace plastics material away from the seam to such an extent that the thickness at the seam is less than one half of the combined thicknesses before the sheets were compressed.

3. A method of fabricating an insulated structure as herein described with reference to the accompanying drawings.

4. Apparatus for fabricating an insulated structure forming part of the casing of a refrigeration appliance, comprising means for applying reduced pressure to draw a pair of sheets of plastics material against opposed tools to form respective layers which provide inner and outer skins of the appliance casing, wherein means is provided for bringing the tools together with a force sufficient to displace plastics material away from a peripheral seam along which the sheets are welded.

5. An insulated structure fabricated in accordance with the method of claims 1 or 2.

6. An insulated structure as claimed in claim 5, wherein the structure is the door of a refrigeration appliance.

7. An insulated structure as claimed in claim 5, wherein the structure is the cabinet of a refrigeration appliance.

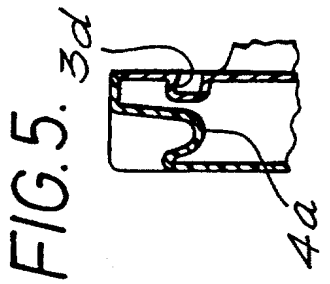


FIG.5.

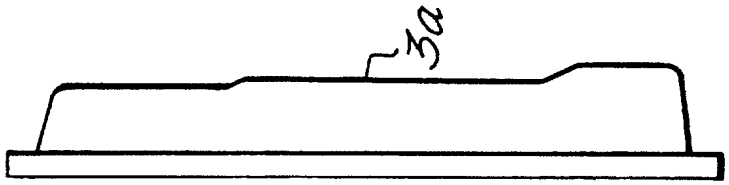


FIG.4.

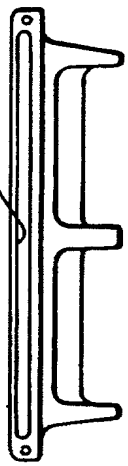


FIG.2

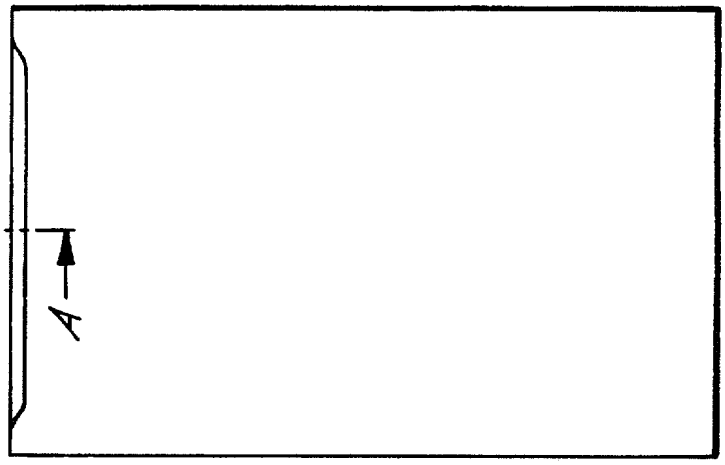


FIG.3.

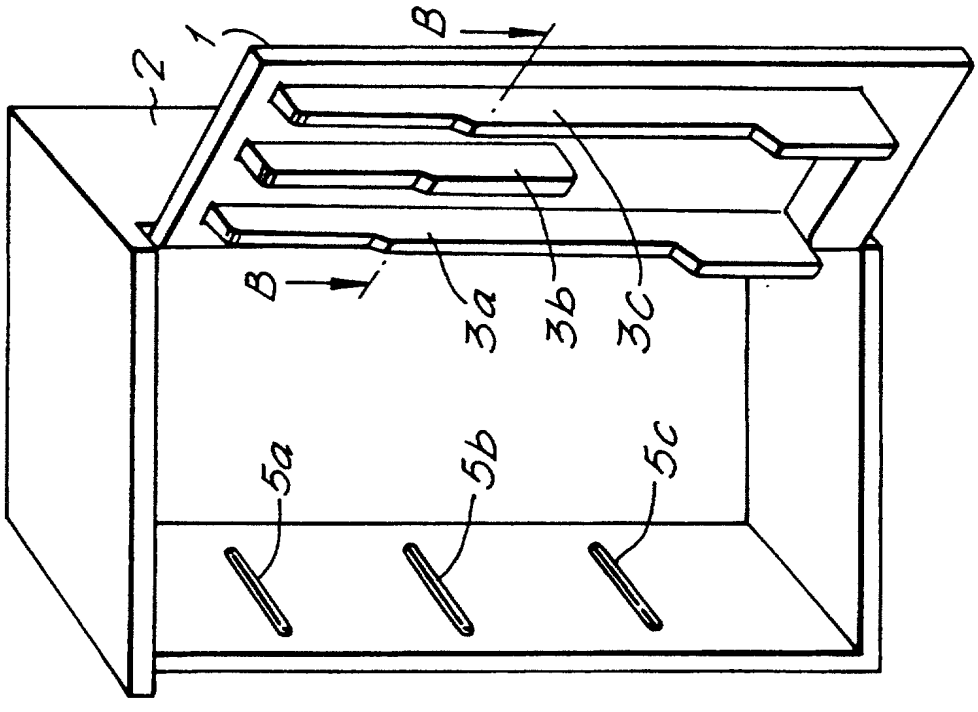
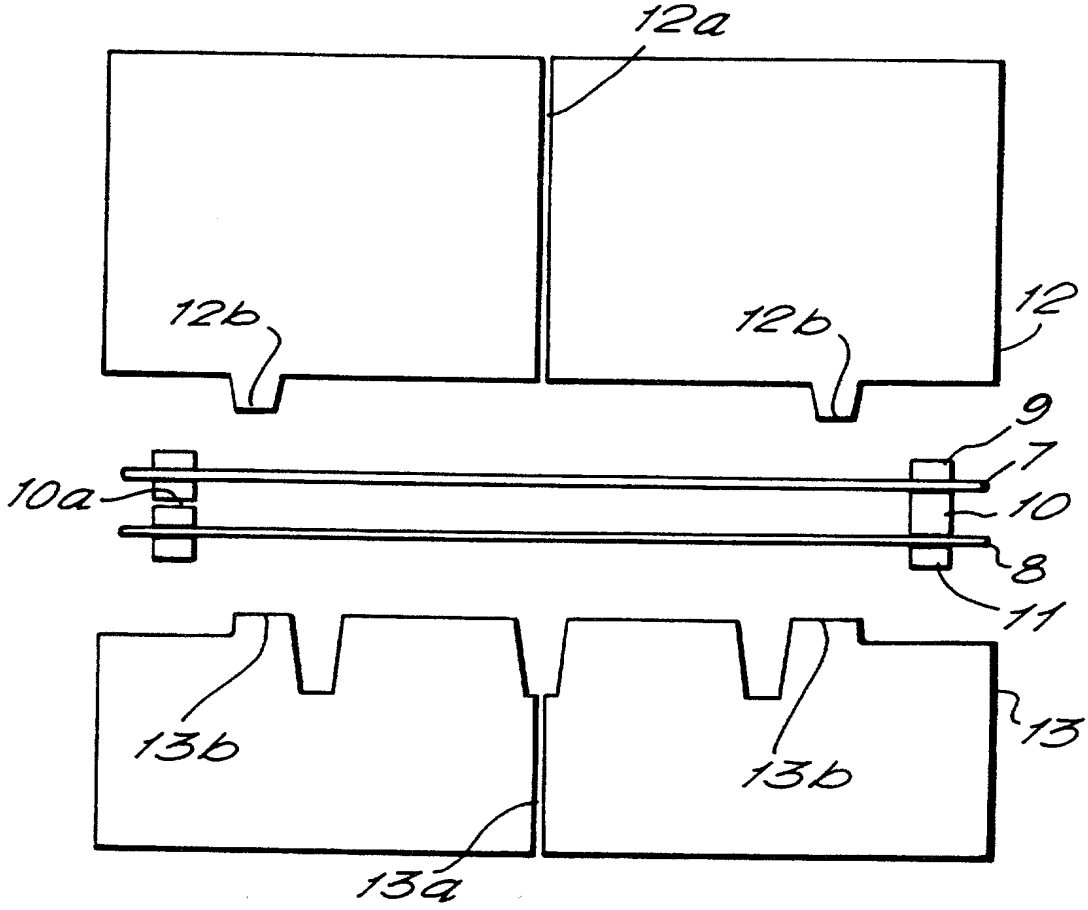


FIG.1.

FIG.6.



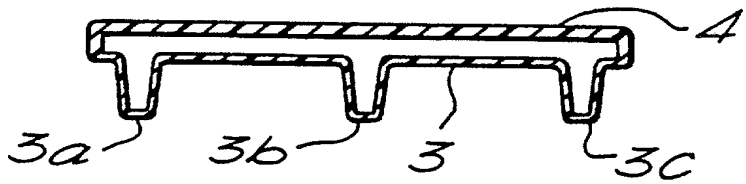


FIG.7.

FIG.8.

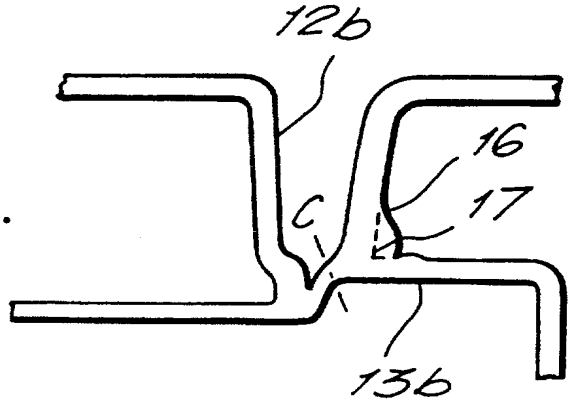


FIG.9.

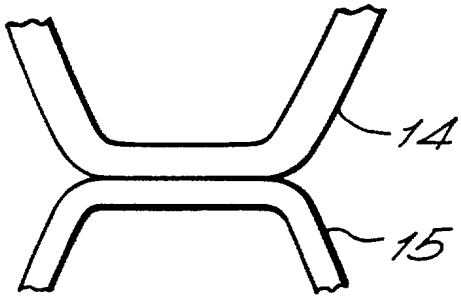
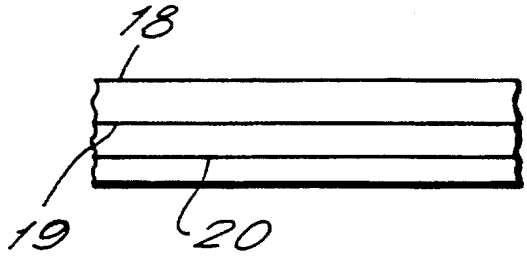


FIG.10.



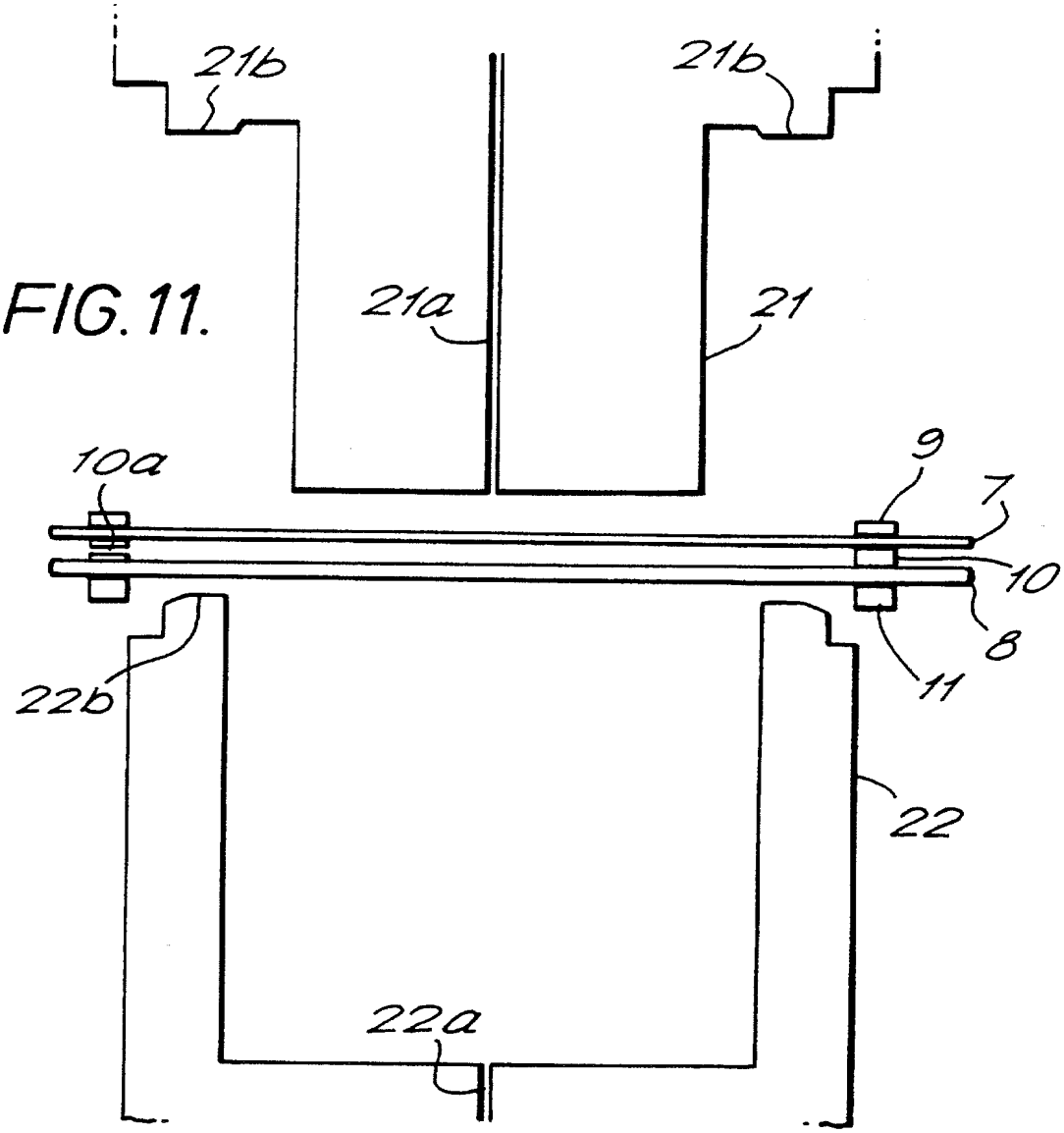


FIG. 11.

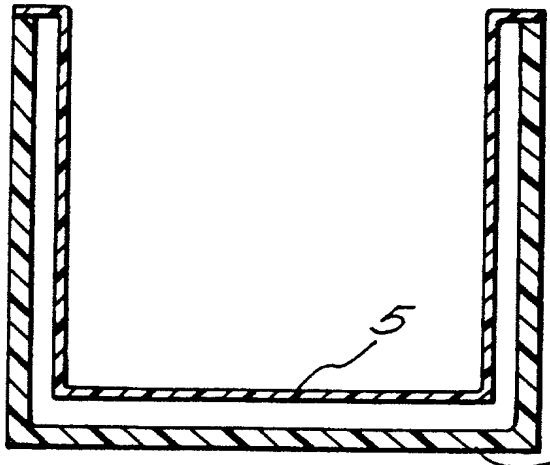


FIG. 12.

INTERNATIONAL SEARCH REPORT

Interr J Application No
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A. CLASSIFICATION OF SUBJECT MATTER
IPC 6 B29C69/00 F25D23/02

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 6 B29C

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	GB,A,2 085 797 (TERAOKA SYOICHI) 6 May 1982 see page 1, line 97 - line 101 see page 3, line 112 - line 118 see page 4, line 77 - line 80 see claims 1,2,8-12; figures 1-6	1-7
X	US,A,3 398 434 (ALESI JOHN JR ET AL) 27 August 1968 see column 10, line 55 - line 68; figures 4,8,9,12-20	1-7
X	US,A,3 311 683 (ALESI JOHN JR ET AL) 28 March 1967 see column 3, line 73 - column 4, line 2; figures 4,8,9	1-7

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[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

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Date of the actual completion of the international search	Date of mailing of the international search report
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C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

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